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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/774,418	02/10/2004	Minh Van Ngo	50432-330	1043
7590	10/07/2004		EXAMINER	
McDERMOTT, WILL & EMERY 600 13th Street, N.W. Washington, DC 20005-3096			BERRY, RENEE R	
			ART UNIT	PAPER NUMBER
			2818	

DATE MAILED: 10/07/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/774,418

Applicant(s)

NGO ET AL.

Examiner

Renee R Berry

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. ____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>2/10/04</u> . | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent No. 6,790,770 to Chen et al. in view of US Patent No. 6,737,747 to Barth et al.

In regards to claim 1, Chen teaches a method of fabricating a semiconductor device, the method comprising: forming an opening in an upper surface of a porous low-k dielectric layer; conducting chemical-mechanical polishing (CMP) leaving this upper surface of the Cu or Cu alloy exposed; and treating the upper with a plasma while controlling plasma conditions to avoid etching the upper surface of the porous low-k material at column 5, lines 13-20.

In regards to claim 3, Chen teaches the method according to claim 2, comprising depositing silicon nitride or silicon carbide as the capping layer at column 10, lines 6-14.

In regards to claim 4, Chen teaches the method according to claim 1, comprising treating the upper surface of the Cu or Cu alloy in an ammonia or hydrogen plasma at column 5, lines 38-46.

In regards to claim 10, Chen teaches the method according to claim 4, comprising forming the opening in a dielectric layer having a dielectric constant (k) up to 2.4. at column 5, lines 20-22

In regards to claim 11, Chen teaches the method according to claim 10, comprising forming the opening in a dielectric layer having a k value of 2.0 to 2.2 at column 5, lines 20-22.

In regards to claim 12, Chen teaches the method according to claim 4, comprising forming the opening as a dual damascene opening at column 5, lines 1-3.

In regards to claim 13, Chen teaches the method according to claim 1, comprising depositing a barrier metal layer lining the opening before filling the opening with the Cu or the Cu alloy at column 5, lines 13-14.

In regards to claim 15, Chen teaches a method of fabricating a semiconductor device, the method comprising: forming a dual damascene opening in an upper surface of a porous dielectric layer; depositing a barrier metal layer lining the opening; filling the opening with copper (Cu) or a Cu alloy; conducting chemical-mechanical polishing (CMP) (column 7, lines 14-19) leaving an upper surface of the Cu or Cu alloy exposed; a pressure of 4.0 to 5.2 torr; and a temperature of 300 °C to 400 °C at column 5, lines 13-20.

In regards to claim 18, Chen teaches the method according to claim 15, comprising forming the opening in a dielectric layer have a k value of 2.0 to 2.2 at column 5, lines 20-22.

However, Chen does not teach all the limitations of the claim.

In regards to claims 1 and 2, Barth teaches the method according to claim 1, further comprising depositing a capping layer on the treated upper surface of the Cu or Cu alloy at column 10, lines 6-14.

In regards to claim 5, Barth teaches the method according to claim 4, comprising treating the upper surface of the Cu or Cu alloy with the plasma at a power of 75 to 125 watts at column 10, lines 28-30.

In regards to claim 8, Barth teaches the method according to claim 4, comprising treating the upper surface of the Cu or Cu alloy with an NH₃ plasma at: an NH₃ flow rate of 100 to 700 sccm; a nitrogen (N₂) flow rate of 2,000 to 9,000 sccm; a power of 35 to 125 watts; a pressure of 4.0 to 5.2 tom and a temperature of 300⁰ C to 400⁰ C; for a pressure of 4.0 to 5.2 torr; and a temperature of 3000 C to 400⁰ C at column 10, lines 14-29.

In regards to claim 14, Barth teaches the method according to claim 13, comprising at column 11, lines 20-26.

In regards to claim 19, Barth teaches a method according to claim 15, comprising depositing silicon nitride or silicon carbide as the capping layer at column 10, lines 6-14.

In regards to claim 20, Barth teaches the method according to claim 15, comprising depositing a layer of tantalum, tantalum nitride, or a composite of tantalum nitride and alpha-tantalum, as the barrier metal layer at column 11, lines 20-26.

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified Chen to include depositing a capping layer on the treated upper surface of the Cu or Cu alloy; treating the upper surface of the Cu or Cu alloy with the plasma at a power of 75 to 125 watts; treating the upper surface of the Cu or Cu alloy with an NH₃ plasma at: an NH₃ flow rate of 100 to 700 sccm; a nitrogen (N₂) flow rate of 2,000 to 9,000 sccm; a power of 35 to 125 watts; a

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pressure of 4.0 to 5.2 tom and a temperature of 300⁰ C to 400⁰ C; for a pressure of 4.0 to 5.2 torr; and a temperature of 3000 C to 400⁰ C; and depositing tantalum, tantalum nitride, or a composite of tantalum nitride and alpha -tantalum, as the barrier metal layer, since such a modification would result in a cap layer having a strong adhesive contact with the metal conductor, at column 3, lines 61-64 of Barth et al.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Renee R Berry whose telephone number is (571) 272-1774. The examiner can normally be reached on M-F 9-5:30.

The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



RRB

September 21, 2004



**GENE N. AUDUONG
PRIMARY EXAMINER**